

Construction Requirements

TZA22003-10262

1. SPECIFIC REQUIREMENTS

1.1. Specifications

The Contractor must read carefully all the specifications and workmanship indicated in this section in order to attain required work quality.

General/ Guiding Specifications

This project will focus on minimising the use concrete as much as possible and the use sustainable green construction materials as mentioned below.

Green construction materials to be used in construction

- Stones: The stones are locally available to around the villages where there is a site.
- ISSB bricks: This is more sustainable compared to burnt bricks and cement bricks/blocks. The energy used to produce ISSB is lower than other materials. See table three below

Embodied Energy and Carbon in Construction

S/N	Phase	Burnt Bricks		Sand – Cement Blocks		Interlocking Bricks (SSIB)	
		Embodied Energy (MJ)	Embodied Carbon (KgCO ₂)	Embodied Energy (MJ)	Embodied Carbon (KgCO ₂)	Embodied Energy (MJ)	Embodied Carbon (KgCO ₂)
1	Substructure	22,786.03	1,817.17	20,136.34	1,684.54	20,136.34	1,684.54
2	Superstructure	51,128.24	4,235.13	38,205.51	4,744.09	29,320.37	3,087.87
3	Roofing	8,154.41	420.17	8,154.41	420.17	8,154.41	420.17
4	Finishing	8,150	910.66	9,831.6	1,223.4	9,725.04	1,216.9
6	Doors and Windows	9,064.23	318.6	9,064.23	318.6	9,064.23	318.6
Total		99,282.91	7,701.73	85,392.09	8,390.8	76,400.39	6,728.08

Summary of Embodied Energy and Carbon in construction stages (source <https://www.nhbra.go.tz/pages/our-products>).

- **Timbers grown at Kigoma:** Well-treated timbers grown at Kigoma instead of steel which must be imported from China or transported from Dar Es Salaam. We will use

eucalyptus, and pines for formworks, scaffolding, and roof trusses since they are readily available here at Kigoma the growth rate is fast, and less transport distance hence less carbon emission. Not all timber used in the formwork can be recycled and used for roofing if well-cleaned and preserved.

The Construction of dormitories will be limited to the following components

- 1. Erection of structure:** The sustainable materials to be used are stone masonry foundation, hardcore, and walling with Interlocking soil-stabilized bricks (ISSB). The top of the hardcore there will be a 100mm thick plain concrete with (a mixing ratio of 1:2:4 batched by volume). The ring beam will be of reinforced concrete grade 20 at a height of 3.1m from DPC level as shown in the attached drawings.
- 2. Roofing:** The roof type will be a mono roof with timber trusses anchorage to the ring beam by 6mm bars casted at the concrete ring beam, timber trusses to be used due to its sustainability and will use IT5 28 gauge colourless resin- coated roof covering material to reduce heat absorption in the house. The roof shall have cross ventilation to enhance the cooling inside the rooms by reducing heat from the roof via the ceiling.
 - ◆ The overhang will be of 1.5m horizontal length to prevent direct sunlight to the walls hence maintaining the room temperature very normal and comfortable without the need for high conventional energy to cool the house. To enable the cross-ventilation the gable part of the roof will be filled with perforated bricks provided with fixation of coffee mesh wire at the inner side of the wall to prevent/reduce dust from entering and stacking on the ceiling.
 - ◆ The roof at the laundry: This will cover only half of the laundry area this is because the findings of a participation design survey shows that 50% of the girls prefer to work under the roofed shed rather than in direct light.
 - ◆ Gutters: will be of 180mm wide round PVC gutter supported/fixed to the fascia board at 50cm c/c spacing. The fascia board will be fixed to the rafter supporter by timber brackets. The downpipes shall be of 100mm in diameter and directed to the ferrocement tank on the ground. The overflow water to be channelled to the drainage ditch.
 - ◆ Drainage ditch: will be of stone-lined masonry covered on top with 150 RC slab at every section where it will be passing across the house hallway floor. The internal dimension shall be 03.m with and 0.3m depth.
- 3. Dhobi sinks:** will be of construction with concrete grade 20 with 6mm BRC mesh, finished with Terrazo.
- 4. Fence wall connecting the dormitory with its WASH:** The wall will be built with a stone masonry foundation and the walling of ISSB brick 230mm thick. The height of the fence will be 2.8m high and a ring beam of 0.25m thick on top then the concrete capping will be added to drain overhead rain. Note that the wall will be solid from DPC level to 1.7m high the rest portion of 1.1m high will be perforated brick wall.
- 5. Access Ramps 1.5m wide:** All ramps shall have a slope of 8° provided with guard handrails at the one side as indicated in drawings. The ramp must not be longer than 3m otherwise, it must be provided with a landing of 2m long.
- 6. Partition walls:** Every three rooms/cubes will be having shorts partition wall of 2m high so as to reduce the privacy of the girls the aim is a girl standing on the bed at the first room can be able to see her friend to the third room. the next set shall be separated with full height wall to the ceiling.

7. Finishing works:

- ♦ Floor finishing: use of terrazzo which is a better option as its energy consumption and carbon footprint are significantly lower.
 - ♦ Plastering: internal wall surfaces will be plastered with cement, sand 1:4
 - ♦ External wall finishing: ISSB bricks will be polished with three coats of seed oil. The second and the third coats shall be applied after drying of previous coat.
 - ♦ Toilet wall finishing: a 150mm high will be terrazzo skirtings. • Laundry wall and concrete dhobi sink finishing: It will be finished with terrazzo.
 - ♦ Painting works: All surfaces of internal walls and external shall be cleaned, skimmed, smooth, primed with binder paint to remove dust, and then finished with three coats of finishing paint. Apply weathered outside and silk inside walls.
8. **Provision of electricity:** This work shall be limited to fixing conduits, wiring, and connecting the building to the TANESCO electrical post which must be within the school otherwise it shall not be done. If there is no electrical post at school, then, upon agreement and written confirmation, the client will be responsible to bring electrical post at school or provide the solar power station at school where the contractor will have to connect electricity. In other words the contractor will not be involved in extending the electrical post to the dormitories.
9. **Provision of water supply:** the contractor will be obligated to connect water from the raised poly tank storage which will be at school compound near the toilets. The contractor will not connect water from neither RUWASA/KUWASA nor borehole.
10. **Incinerator:** will be constructed using fired bricks with well selected muddy mortar or as shall be directed by the Contracting Authority, its walls must not touch the walls of the building, and the height of the chimney must exceed the roof of the toilet by 2m.
11. **Water harvesting:** On ground two polytanks of each 10,000 litres will be installed by a contractor on the base to collect a total of 20,000 litres as specified in the drawings.
12. **Doors at Sleeping Rooms:** Doors will be made with Hard wood (full matured mninga or the like). The doors frame will have 2,8m high, vent of the door will have burglar bars and clear glass to all light to pass. Also, the door will have 300mmx300mm an air ventilation near bottom. Door will be fixed to the frames with three hinges and will have a 3- level mortice lockset.
13. **Windows:** Windows will be made of heavy-duty aluminium sliding window units with top-hung transom, fabricated from extruded aluminium alloy 6063-T5/T6; main frame 100×50 mm (1.4–1.8 mm thick), sliding shutters 26×50 mm (1.2–1.4 mm thick) with 26×50 mm interlock (1.8 mm thick); glazed with 5 mm tinted float glass with machine-polished edges, fixed with EPDM gaskets; complete with aluminium-framed stainless steel mosquito net (Grade 316), friction stays, safety restrictors, locks, rollers and all necessary ironmongery; powder-coated finish (60–80 microns) colour as approved; including mullions, transoms, glazing beads and all accessories; fixed to concrete/blockwork openings, sealed all round complete.
14. **Firefighting:** The building will be provided with 10 smoke sensors and 4 fire extinguishers which shall be fixed at a place that is accessible by everyone.

2. QUALITY AND CONTROL

2.1. Expected quality of work

- a. The ISSB bricks contractor will have to achieve a compressive strength of min. 3.5N/mm² and submit test results of the bricks to the Consultant copying the Managing Official before mass production. All the work which will be under quality shall be demolished and unpaid.
- b. The foundation strip shall be uniformly compacted using a mechanically operated tamping rammer (commonly called a jamping jack or “mguu wa jini”) to achieve 95% Maximum dry density. Compaction shall be carried out in layers, ensuring the formation level is firm, level, and free from loose or disturbed material prior to the construction of the stone masonry foundation.
- c. Hard stones (mawe chuma) at least 30cm length, rough texture, non-round.
- d. Concrete works: all concrete must be cured by at least 28 days, slump and cube tests must be taken and results submitted to the Consultant copying the Managing Official.
- e. Untreated timber will be rejected
- f. All the walls, beams and columns must be straight any bad work will be rejected.
- g. All timbers shall be treated up to the inside of the timber itself not just to the surface.
- h. The terrazzo floor must be waterproof without voids underneath, and the level must a smooth and even surface finish without irregularities.
- i. The plumbing system must be of good quality without any leakage. The plumbing system shall be tested before handing over.
- j. Electricity: shall be tested before handing over: the wires to be used must be pure copper, and wiring should be done in such a way that no energy loss, no tripping, and no electric shorts.
- k. The solar light post must have adequate shear stiffness at the base and be well welded and casted to the concrete base with concrete grade 20. The base plate will be anchored with J-bolts and fixed with the 20mm 4 bolts plus 50mm dia. washers.

2.2. Detailed/ execution-level requirements

1. Land scaping and Site Drainage: Provide back slope (1:2) and construct stone-lined cutoff drain to divert runoff.
2. Land scaping: on the back slope surface: stabilize the slope surface by planting grasses
3. The oversite concrete shall be Grade 20. The batching and mixing ratios shall be determined through laboratory testing to establish an appropriate site mix design for adoption. Prior to casting, provide movement (expansion) joints or crack control joints at intervals not exceeding 5 meters.
4. Drainage (Courtyard): Install double 6” Class C PVC pipes; inlet level at 300 mm below oversite concrete.
5. Wall Protection: Fix 1”x6” hardwood timber strip at 900 mm height to protect walls from damage.
6. Door Ventilations: Install 300x300 mm low-level ventilation openings on door panels.
7. Window Ventilations: Adopt design with at least 15% ventilation to ensure airflow even when closed.
8. Roof covering materials: Use light reflective resin coated roof covering sheet. Do not provide dark color which absorbed heat.

9. Roof covering on valley: Use 450 mm wide valley gutters fabricated on site.
10. Door Fixing: Use 4 pcs 8 mm diameter, 6" long fisher bolts per frame (fixed at jambs).
11. Connection between metal column and tie beam on veranda/ walkways: use 10mm bolts with nuts and 2" washers
12. Sun & orthogonal Rain Control: Plant trees perpendicular to windows at 6 m offset to replace the sunshade provided by government.
13. Provide grated ceiling ventilation at eaves (600 mm from fascia); use angle frame with perforated sheet (5 mm holes), painted white.
14. Chamfer walls corners or install timber protection to prevent damage from moving objects.
15. Add door vents on both sides and fix 30% perforated transparent panels to increase day lighting and air flow inside rooms; width: 900 mm each side.
16. Toilet and Bath in dormitory: cast waterproof terrazzo up to 1.5 m height. The width of finished internal room dimension should not be less than 90cm.
17. Dhobi Sink: Apply terrazzo finish to all surfaces, including 70cm high to walls with provision for water tap.
18. Fence wall: Plaster fence wall connecting dormitory, tank raiser, and WASH; add coping to drain water away.
19. Incinerator Room: add roof shed be higher than wash roof by 0.5m.
20. Plaster mix ratio should very strong of 1:3 (cement: sand) and include waterproofing admixture for the SWASH facilities interior walls.
21. Adjust roof pitch to 10° and include bird-net/gauze details
22. Add steps at the incinerator to allow accessibility.
23. Add coping on perforated wall of the incinerator with 50mm overhang to prevent water ingress
24. Aluminum windows shall be of 5mm glass thickness and 8mm thick profile.
25. Incinerator room grill door to include 3mm thick metal at the middle part and wire mesh at the bottom and top for security and privacy.
26. Incinerator Alignment: incinerator layout shall provide a minimum clear passage of 900 mm all around the incinerator for safe operation and maintenance. Adopt this alignment to enhance accessibility.
27. Construction of Burning Chamber Walls: the burning chamber walls shall be constructed using 150 mm thick burnt brick masonry bonded with mud mortar.
28. Openings and Access Doors: Indicate and detail three (3) openings as follows: Top opening: see label "A" in attached plan
 - ◆ Size: 150 mm × 150 mm
 - ◆ Purpose: Waste dropping opening designed to prevent users from seeing waste from other users.
 - ◆ Section detail shall show that:
 - ◆ The grilled door level is 50 mm above the top concrete level.

- ◆ The grilled door is sloped/shaded to prevent rainwater from entering the burning chamber.
 - ◆ Burning chamber door: Size: 300 mm × 300 mm
 - ◆ Ash chamber door: Size: 300 mm × 300 mm
29. Chimney Height: the incinerator chimney shall extend at least 2.0 m above the highest roof level.
30. Grilled Door Specifications:
- ◆ Grilled shutter plates shall be 6 mm thick mild steel.
 - ◆ Door frames shall be fabricated from 1.5" × 1.5" hollow steel sections.
 - ◆ Cover the grill with a plate of 3mm thick at a height of 1.3mm high from floor level for privacy.
31. Roof Provision: The roof level shall be raised at least 500 mm above the adjacent washroom roof to allow proper dissipation of fumes.
32. Roof Support Structure: The proposed roof is a light shade supported by 3" diameter black steel pipes, cast and anchored on top of the ring beam.
33. Outlet Gate / Grill Landing: At the outlet gate or grill area, provide a landing space sufficient to allow a 360-degree turning radius of 1200 mm when the gate is fully opened.
34. Plastering: A 60 mm high skirting plaster constructed to all external walls to prevent water splashes from directly impacting the ISSB (Interlocking Stabilized Soil Blocks).
35. Incinerator Floor Level: the incinerator floor level is sloped outward toward the gate to drain water away from the incinerator room. Incinerator is built on a concrete plat form raised by 75mm from ground level.
36. Washroom Drainage: water from washrooms should be directed to floor drains or squatting pans.
37. Changing Room Door: The door from the changing room leading to the incinerator room shall be repositioned to the corner, as indicated in the sketch.
38. Main Entrance Doors:
- ◆ Add a grilled steel door at the main entrance opening.
 - ◆ Doors shall open outwards for safety and accessibility.
 - ◆ Use 1.5" × 1.5" square hollow section, minimum thickness 3.0 mm. Cover with 2mm thick metal sheet up to a height of 1.3m from floor level.
39. Roof Structure Front Shade Beam for wash:
- ◆ A 2" × 6" timber beam fixed on top of the concrete beam on one side
 - ◆ Bolted to the black steel pipe on the other side using M10 bolts.
40. Roof Truss Anchorage: all roof trusses shall be anchored to the ring beam using 6 mm diameter mild steel bars ($f_y = 350 \text{ N/mm}^2$).

41. Access Ramps: ramp orientation and alignment shall be executed as per site engineer's instructions.
42. Sewage System: Wastewater from the left-side WC sinks shall be connected directly to the septic tank inlet chamber. Wastewater from the right-side WC sinks shall also be routed separately and directly to the same septic tank inlet chamber, maintaining independent flow paths until entry.
43. Alterations, additions and Extensions. In alterations or extensions to the existing works, buildings and/or external work, new work is to match up in all respects to the existing work unless otherwise specified, shown on the Drawings or approved before-hand by the Engineer.

2.3. Quality samples testing and approval

a. Materials

All materials, commodities, components and equipment are to be approved by the Managing Official as advised by the Contracting Authority's Supervising Engineer and the Consultant before the purchase; must also be new and unused. Handle, store, fix and protect all commodities with care to ensure that they are in perfect condition when incorporated into works and handed over on completion.

b. Manufacturer's recommendations

Handling, storage and fixing of every commodity shall be in accordance with the printed or written recommendations of the manufacturer and/or supplier. Supply the Consultant copying the Managing Official and the Contracting Authority's Supervising Engineer with copies of manufacturer's recommendations. Inform the Engineer if the manufacturer's recommendations conflict with any other specified requirements, and obtain his instructions before proceeding.

c. Standards

Where commodities or workmanship are specified by reference of British Standard (BS) or codes of practice (CP) or International (ISO) or Tanzania Standard or other Standards, such standards are deemed to be the latest published at the time of tendering. The Contractor will be deemed to have read and understood the standards specified, and no claim of want of knowledge will be allowed. The substitution of commodities or standards of workmanship complying with other standards may be well allowed at the discretion of the Managing Official, but application for permission for such substitution must be made in writing in sufficient time to allow adequate investigation. Obtain Certificate of Compliance with standards and supply to the Managing Official on request.

d. IFC EDGE Certification

IFC EDGE certification is an internationally recognized green building certification system developed by the International Finance Corporation (IFC), a member of the World Bank Group. EDGE certification focuses on achieving measurable reductions in:

- ◆ Energy Consumption
- ◆ Water Consumption
- ◆ Embodied Energy in Materials The Contractor shall fully support and take responsibility for achieving at least 20% certification level for each of the above listed measurable reductions by complying with all sustainability requirements related to the works.

e. Local conditions

All materials, commodities, components and equipment must be suitable for use in tropical climates.

- f. Samples Where samples of commodities or specimens of finished work are specified submit samples or specimens to the Consultant and obtain approval before confirming orders or carrying out the work. Finished work must conform in all respects with the samples or specimens approved. Remove samples and specimens when no longer required. The cost of supplying samples and specimens deemed to be included in finished work.

2.4. WORKMANSHIP

The Contractor is required to visit the existing buildings and ascertain for himself the nature of the Works and no claim arising from want of knowledge in this respect will be allowed. The dimensions and quantities given in this section are approximate given for guidance only and the Contractor is referred to the Site to ascertain the exact nature of the works.

The items of pulling down and alterations are to include for both labour and materials and for any shoring, needling and strutting and temporary works in connection therewith. The contractor must allow in his pricing for making good all works disturbed in all trades and for carting away all debris arising.

The Contractor must give all necessary notices and must exercise due care in the demolitions. He must not collapse large sections of walls, floors, etc, and must provide all necessary shoring and supports during the demolitions.

2.5. EXCAVATION AND EARTHWORK

- a. Nature of excavation.
The contractor must ascertain for him the nature of the material to be excavated and price work accordingly as no allowance will be made beyond the contract sum of any alleged ignorance in this respect.
- b. Excavations generally
Excavations have been measured from the drawings including the Engineer's site plan showing existing contours. It is the responsibility of the contractor to check the commencing levels prior to commencing the work as no extra payment will be made in respect of any alleged excavations carried out due to the commencing levels being above that shown upon the drawings without the prior written agreement of the Structural Engineer prior to commencement of excavation.
- c. Site clearance
The contractor shall clear the construction areas within the site of all bushes, roots, boulders, natural obstructions, rubbish and any other natural or artificial obstructions, which would interfere with construction of buildings, roads, paths and drains.
- d. Over-site excavation.
Excavated material suitable for back-filling around foundations and for making up levels under roads, floors etc., is to be kept separate from soil spoil heaps and to be re-used as directed or spread and levelled on the site at the end of excavation operations when found to be surplus. The Quantity Surveyor will measure the amount of any such disposal on site. Vegetable soil is not to be used for back filling around foundations.
- e. Excavations for Foundations and Structures.
Excavations for foundations and the reinforced concrete structure shall be to the widths, depth and levels to accommodate the structure shown on the drawings. Working space has been allowed for in the measurement of excavation quantities given in these Bills of Quantities in accordance with the rules of measurement laid down elsewhere in these Bills, namely 1.00 metre from the face of any work which requires formwork over 1m deep below the starting level of excavation, and 0.30 metre from face of any work which requires formwork not exceeding 1 metre deep below starting level of excavation.

Generally formwork has not been measured for plain concrete foundations or column bases and therefore, excavations for these has been measured net. Formwork has been measured to reinforced concrete foundations and column bases and all faces of columns and walls and working space excavation has been measured and included accordingly. Adjustments to excavations widths as measured will, therefore, be made only in the case of the Structural Engineer ordering the addition of formwork to plain concrete foundations etc, or the omissions of formwork to reinforced concrete foundations or column bases. Ordinary use of planking and strutting along foundations to prevent earth falls and to save concrete will not be considered as formwork.

2.6. Rock

Rock shall be defined as "Compact rock of such hardness and compaction that it cannot be removed with a pick but requires the use of sledges or compressor driven tools or blasting to remove it," and the Consultant's opinion shall be final. Excavation in any material such as compacted murrum, soft tuff, stiff clay or similar materials which in the opinion of the Consultant can be reasonably be removed by pick, traxcavator or similar means will be deemed to be included in the prices for normal excavation. All material classified as rock may, if approved by the Consultant be used as hardcore filling and the measured quantities of imported fillings will be adjusted accordingly. All rock so used must be broken to the required size as hereafter described before being so used.

2.7. Blasting

No blasting will be permitted.

2.8. Inspection

When the excavations have been made to the sizes and depths required from the drawings, the Structural Engineer shall be called to the site immediately for an inspection, and upon approval the Contractor shall proceed with the work to prevent rainwater or other surface water draining into the foundations. The excavations are to be left open until any variation in depth has been measured and agreed.

2.9. Excavation below required depths

Should any excavation be made below the levels or lines shown on the drawings or otherwise required by the Structural Engineer, the contractor must fill up the resultant over-excavation to the proper levels or lines with concrete nominal mix (1:4:8) at his own expense (see "concrete work").

2.10. Filling

The fill shall be clean, selected coarse sand or gravel. It should be taken from borrow pits if the soil on the site is found to contain too much fines and to have too low plasticity limit to be used as fill.

The fill shall be deposited in horizontal layers of maximum 200mm thickness. As soon as possible after the fill is laid out, it should be compacted in minimum three passes of a vibratory-roller and/or vibrating plate compactor. The equipment to be used must be approved by the Engineer.

At each area (control area) of 500m² compacted fill, three-field density tests (e.g. by the sand replacement method) should be taken randomly.

The Control area shall be accepted if all three-test results are above 97% of the maximum density as determined at a homogenous mixing of all three samples by the Standard Proctor Method. Otherwise, repeat the test, each time with three new samples until the above requirement is met or re-compact and test again.

2.11. Return, fill in and ram

Return, fill in and ram suitable filling material as described above around foundations and other concrete structure in layers not exceeding 150mm thick and carefully ram and

consolidate with power rammer. No filling in shall be executed until concrete foundations etc., have been inspected and approved by the Structural Engineer.

Regardless of the means of back filling and compaction adopted, the contractor is responsible not only for the standard of the work but also for any possible damage of the permanent work or adjacent structure.

2.12. Levelling

No item is measured for levelling and consolidating ground and rates for excavation must include for levelling and preparing the ground for concrete or other works including ramming or rolling.

2.13. Soil sterilisation

Anti-termite treatment is to be carried out by an approved specialist firm who will be required, upon completion of the soil sterilisation, to furnish a written guarantee qualifying the following:

- ◆ That the chemicals applied comply with the requirements specified herein for chemical concentration and rates of application.
- ◆ That the treatment will remain effective against termite infestation for a period of five years.
- ◆ The free re-treatment by the firm of any areas showing signs of infestation before the expiry of the five-year period.

Applied Chemicals shall be in accordance to the International regulations and environmental friendly. Treatment shall not be made when soils of fill are excessively wet or immediately after heavy rain.

Precautions must also be taken to prevent disturbance of the treatment by animals or human contact with the treated soil. The treated area is to be covered as quickly as possible after treatment.

All anti-termite chemicals shall comply with applicable international regulations and environmental health standards, including but not limited to:

- ◆ World Health Organization (WHO) guidelines for pesticide safety
- ◆ Stockholm Convention on Persistent Organic Pollutants (POPs), prohibiting highly toxic and long-lasting chemicals such as certain organochlorines (e.g., chlordane, aldrin, dieldrin)
- ◆ FAO (Food and Agriculture Organization) International Code of Conduct on Pesticide Management
- ◆ Local environmental and public health authority approvals

Only approved, low-toxicity, environmentally responsible termiticides shall be used. The use of highly toxic, persistent, or bioaccumulative chemicals is strictly prohibited.

Application shall be carried out strictly in accordance with manufacturer instructions and regulatory requirements. Treatment shall not be performed under unsuitable conditions, including:

- ◆ When soil or fill is excessively wet • Immediately following heavy rainfall All necessary precautions shall be taken to: • Prevent contamination of surrounding areas
- ◆ Avoid exposure to humans, animals, or vegetation

- ◆ Ensure treated soil is not disturbed after application

The treated area shall be covered immediately after treatment (as soon as practicable) to protect the integrity of the application and minimize environmental or human exposure risks.

The rate of application is to be 5 litres per square metre and the areas measured include those under floor and round wall and column foundations.

The contractor shall notify the Supervising Engineer in sufficient time before the filling of foundation trenches and laying of concrete floor bed in order that the Architect may nominate a specialist firm to execute the soil sterilisation.

Any additional costs caused by the contractor not rendering sufficient prior notice to the Managing Official will be borne entirely by the Contractor.

2.14. Disposal of surplus excavated material

Surplus excavated material will be carted away from the vicinity of the walls and deposited, spread and levelled on areas to be allocated by the Structural Engineer, reasonably adjacent to the site.

2.15. Disposal of water

The contractor shall keep the excavations free from standing water and silt (or excavated material softened by water) and he shall include for the cost of pumping, construction of temporary drains; soak-way pits, etc., as deemed necessary to achieve this. An item has been included for this in the Bills in each relevant section. A Provisional Sum has covered the cost of pumping to dispose of any spring or running water. If spring or running water is encountered the cost of any pumping ordered by the Structural Engineer will be paid for in accordance with the Day-works schedule.

2.16. Planking and strutting

Sides of all excavations must be supported in order to prevent falls from or collapse of the earth face. The "Planking and Strutting" is deemed to include any method or methods, which the contractor elects to adopt to uphold, protect and maintain the sides of excavations. The contractor will be responsible for any consequences of his failure in this respect including clearing away fallen materials and any extra concrete or other works including formwork ordered by the Structural Engineer due to such failure. An item has been included in these Bills in each relevant section.

2.17. Hardcore

Hardcore shall be hard crushed stone to pass a 100mm ring in all directions. No sand, quarry dust or fine material will be permitted. All hardcore beds shall be topped with a layer of fine stone or aggregates minimum size 12mm to fill the voids on the surface to receive concrete beds. Rates for hardcore shall include for levelling or finishing or laying to falls and consolidating by rolling as described for "Filling" above.

2.18. Rates for Excavations

The rates for excavation, including excavation in rock, shall include for trimming, levelling and preparing bottoms and all faces to receive concrete, etc, and for any extra excavation required for planking and strutting.

Prices shall include for excavating in any material encountered unless specifically otherwise described, handling, etc, of extra bulk after excavating, or before consolidating, any extra excavation required for formwork or planking and strutting, circular work, grubbing up of any old drains, roots etc, that may be encountered, for trimming sides and levelling and ramming bottoms, forming steppings and trimming excavations or filling to embankments and batters as required.

In rates for item “allow for keeping the whole of excavations free from water” the Contractor shall allow and make provision for keeping the whole Works thoroughly drained and clear of water below the lowest level of any part of them so long as may be required if considered necessary by the Engineer, continuously day and night by petrol or hand pumps or other mechanical appliances, pipes, chutes, dams, manholes, sumps, diversions or any other means necessary for the that purpose. Water pumped from trenches shall not be allowed to run down the road channels but shall be conveyed to the nearest surface water sewer, ditch or river through troughs, chutes or pipes.

2.19. Cutting down trees

The Contractor must consult the Supervising Engineer before cutting down or pruning any trees or shrubs encountered on the site.

2.20. CONCRETE WORK

a. Materials and workmanship generally

The recommendations of the recent British Standard Codes of Practice BS 8110 for the Structural use of reinforced concrete in buildings shall be deemed to be incorporated in these preamble clauses unless otherwise specifically stated.

b. Materials generally

All materials to be used in the works shall conform as to quality and description as specified hereunder and shall be equal to approved samples. In particular no materials shall be used until approved samples shall be supplied to the Consulting Engineer for approval at least one week before ordering in bulk and delivery to the site. Any material delivered to the site, which, has not been previously approved by the Structural Engineer shall be the Contractor's liability. All materials shall be transported, handled and stored on site so as to preclude damage deterioration or contamination. All condemned materials are to be removed from the site within 24 hours.

c. Cement

The cement, unless otherwise specified on the drawings shall be Ordinary Portland Cement of approved manufacture, delivered in the manufacturer's bags and shall comply in all respects with the requirements of the latest British Standard 12. The consignments of cement shall be delivered in sealed bags and shall be stored on the site so as to be used in the order in which they are delivered. The structural engineer shall have the right to take samples for testing in accordance with BS. 12 and the contractor are to obtain current certificates of test from the manufacturer prior to bulk deliveries. Under no circumstances is High Alumina Cement to be used.

Rapid hardening cement may be used in lieu of ordinary Portland cement only with the prior approval of the Architect or Engineer, provided that all conditions applying to its use are strictly observed. Any additional expenses in connection with the use of such cement shall be borne by the Contractor.

d. Aggregate generally

All aggregate shall be from approved reputable sources and shall be strong, hard, durable or limited porosity, free from dust, soft materials, earth or other extraneous matter, and washed and / or screened by the Contractor if so required by the Structural Engineer. Samples shall be provided as often as called upon by the Structural Engineer for testing in accordance with BS. 882. Normal aggregates will have particle densities of greater than 2000 Kg / m³ but not exceeding 3,000 Kg/ m³. Only approved materials shall be used.

Graded samples of all types of aggregate shall, after approval, be kept on site behind glass for visual checking of subsequent deliveries for grading, shape and where applicable, colour. Aggregate shall be stored on site on paved areas with divisions

between each type of aggregate, and shall be used in the order in which they are received on site. No aggregate shall be stored directly on the ground.

e. Fine Aggregate

The Contractor shall ensure that the grading of fine aggregate shall be such that not more than 10% by weight shall exceed 5mm in size and not more than 10% by weight shall pass a sieve BS. No. 100. Between these limits the grading shall conform to the grading for either zone 1, 2 or 3 (BS.882).

f. Coarse aggregate

Coarse aggregate shall be clean, well-graded crushed granite stone or other equal and approved stone quarry and washed if required by the Structural Engineer. The pieces shall be angular or rounded in shape and shall have granular or crystalline or smooth (but not glassy) non-powdery surface. Flakey and laminated pieces, mica and shale shall only be present in such quantities as not to affect adversely the strength and durability of the concrete.

The four nominal aggregate sizes shall be 40mm (1½"); 20mm (¾"); 10mm (⅜"); 6mm (¼"); and the grading when analysed as described in BS. 812 shall be within the limits given in BS. 882. Structural Engineer will specify sizes of aggregates to be used in specific areas. For most work 20 mm maximum size aggregates will be used. The nominal maximum size of coarse aggregates should be not greater than ¼ of the minimum thickness of concrete section or element.

g. Water

Water used for mixing of concrete, washing out of shuttering and similar purpose shall be clean, fresh and free from organic impurities in amounts likely to impair the quality of the concrete and should comply with requirements of BS 5328 and BS 3148:1980 "Methods of test for water for making concrete".

h. Admixtures

Structural Engineer will approve all concrete admixtures after submission of specifications or proprietary brands and relevant trial mix verification at site by Contractor. Admixtures to comply with BS 5075: Concrete Admixtures.

i. Steel reinforcement

Steel for reinforced concrete shall comply with the following specification:

- Mild steel rod reinforcement shall comply with BS. 4449.
- High tensile steel reinforcement shall be either cold worked deformed steel bars of circular octagonal section complying with BS. 4461 or hot rolled deformed high tensile bars having a guaranteed minimum yield stress of 500 N/mm² and other physical qualities in accordance with BS. 4449
- Welded steel fabric reinforcement shall comply with BS. 4483
- BS. 8110, the structural use of reinforced concrete in buildings.

An approved manufacturer shall supply all steel reinforcement; and the contractor may be required to obtain a manufacturer's test certificate in respect of steel reinforcement supplied. In the absence of such a test certificate, the contractor may be required to submit samples to be tested at the contractor's expense in such manner as to comply with BS 8110 requirements.

The steel shall be stored so that it is kept clean and reasonably free from rust.

The placing of all reinforcement shall be checked by the Engineer and in no circumstances is concrete to be deposited around any steel that has not been passed. At least twenty-four hours' notice shall be given to the Engineer that reinforcement will be ready for inspection.

j. Bending and fixing of reinforcement

All bending, cutting and fixing to be in compliance with the British Standard code of Practice, BS 8110 and BS 4466 Bending schedules are incorporated in the contract drawings.

The number, size, form and position of all reinforcement shall unless otherwise directed or permitted by the Architect, be strictly in accordance with the drawings. Bars shall be of the required lengths, and lapping, except where indicated on the drawings, is not permitted unless approved by the Engineer.

Overall dimensions shall not be exceeded and shall not be less than 6mm below the required dimensions. The sizes of links and the like shall be within tolerance of 3mm under or over the specified dimensions.

Any tolerance in the top length of the bar as cut shall be taken up in the end hooks or other approved portions of the bar. The internal radius of the bends at corners of links and the like shall equal half the diameter of the bar embraced by the link.

Laps in bars of random lengths shall be staggered in such a way that no more than 1/3 of bars having same number are to be lapped in the same section.

The steel reinforcement shall be assembled and fixed in the form of a rigid cage. To prevent displacement before or during concreting the bars shall be secured to each other with approved wire. Concrete distance blocks shall, unless otherwise directed, be used between the reinforcement and the bottom and sides of the forms to ensure correct concrete cover to the bars, as specified on the drawings. The specified cover shall be provided and maintained within the specified tolerance.

The minimum clear distance between adjacent bars shall be 25mm horizontally and 25mm vertically. Spacer bars shall be inserted at such intervals that the bars do not perceptibly sag.

Great care must be taken to ensure the correct positioning of beam and column starter bars and to secure projecting bars against displacement both during and after concreting. At the time of fixing and when concrete is being placed, all reinforcement shall be free from oil, paint, grease excessive dust and scale or any other coating, which would destroy its bond with the concrete.

k. Formwork to produce a fair face board finish (wrought formwork)

Formwork described as wrought shall be constructed of or lined with 100mm wide planed boards well cramped together or plywood to leave a fair smooth finish in the exposed concrete face when the shuttering is removed.

l. Construction and Movement joints

The positioning, type and frequency of construction joints are to conform to requirement of BS 8110 and be approved by Engineer. Methods of forming movement joints to follow drawings and the requirements of BS 8110.

m. Concrete grades

Only designed concrete mixes complying with BS 5328 shall be used. Concrete must comply with the requirements set out in the following table according to the grade (This is for guidance only)

GRADE	NOMINAL MIX	MAX.SIZE OF COARSE AGGREGATE	MAX WATER CEMENT RATIO BY WEIGHT	MINIMUM CRUSHING STRENGTH OF WORKS TEST CUBES (N/mm ²)	
				7 DAYS	8 DAYS
30	1:1:2	20mm	0.50	20	30
25	1:1½:3	20mm	0.55	17	25.5
20	1:2:4	20mm	0.60	14	20
15	1:3:6	25mm	0.60	8	15
10	1:4:8	40mm	0.60	-	10

n. Concrete Production, Supervision and Tests

Concrete should be produced in accordance with BS 5328 which requires tests to be made on constituent materials in accordance with relevant British Standards and control tests be made on concrete to ensure compliance with specified requirement. Engineer will in addition approve procedures for placing, compacting, curing and working in hot weather.

Concrete should meet appropriate requirements specified in BS 5328 for

- a. Characteristic compressive strength
- b. Specified mix proportions
- c. Maximum and minimum cement content
- d. Maximum free water/cement ratio
- e. Workability f) Air content of concrete
- f. Temperature of fresh concrete
- g. Density of fully compacted concrete.

o. Preliminary cube tests

The contractor shall specify the sources from which the aggregate will be obtained and shall deliver at his own cost sufficient materials enable preliminary cube tests to be carried out and approved by the Engineer. The Contractor will be responsible for submitting his proposals for the concrete mix proportions together with aggregate grading curves to the Architect for approval and for the payment of the fees of an approved Testing Authority in carrying out the crushing tests. The strength of the preliminary cubes must be a minimum of 33% above those in the above table, which is the minimum works strength.

The approval of any mix by the Engineer will not relieve the contractor of the responsibility for ensuring that all concrete used in the works obtain the minimum works strength shown above. In proportioning the concrete the quantity of cement shall be determined by weight and the quantities of fine and coarse aggregate by either volume or weight, due allowance being made for the moisture content of the aggregate.

Only sufficient water shall be added to the cement and aggregate during mixing to produce a concrete having sufficient workability to enable it to be well consolidated, to be worked into the corners of the shuttering and around the reinforcement, to give the specified surface finish and to have the specified strength. When a suitable amount of water has been determined the resulting consistency shall be maintained throughout the corresponding parts of the work and the slump test or compaction factor test shall be carried out from time to time to ensure the maintenance of this consistency. In no case should the slump be more than 65mm as determined by the standard slump test nor should the compaction factor be more than 0.87 as determined by the standard compaction factor test as described in BS. 1881.

Should the Contractor wish to use patent, plasticising compounds or other admixes, and those shall be approved by the Engineer and be used in accordance with the manufacturer's publications.

p. Work cube tests

Work cube tests shall be made throughout the contract. Each cube shall be inscribed with the date of manufacture and identification mark. A record shall be kept for each batch of cubes showing the position in the works which the concrete represents, the date of manufacture, the mixture and slump of the concrete, particulars of the cement and aggregate used, a statement of whether or not the cubes were vibrated and other information relating to the subsequent history of the cubes.

The cube shall be made, cured and tested in accordance with the requirements of BS. 1881 when directed by the Engineer and in his presence or that of the Approved Testing Authority. A sample of concrete shall be taken at random on eight separate occasions during each of the first 5 days of using that mix.

Thereafter at least one sample shall be taken on each day any concrete of that particular mix is used. From each sample four cubes shall be made two for testing at 7 days and two for testing at 28 days. The works cube results shall be examined both individually and in consecutive (but not overlapping) sets of four, for which the average and the range of each set are calculated. The mix proportions shall be modified to increase the strength if, in the first and consecutive (but not overlapping) sets, any of the following conditions are not satisfied:-

1. Not more than 2 individual results of the 40-cube test should fall below the specified work cube strength.
2. No value of the range in any set should exceed 4 times the designed standard deviation.
3. Not more than one set should have an average, which is less than the specified strength plus $1.1/3$ times the designed standard deviations.
4. No value of the average for any set should be less than the specified strength plus the designed standard deviation.

After 10 consecutive sets of results have been obtained the overall average and the standard deviation of the 40 results shall be calculated and any appropriate modifications made. Subsequently, if any of the foregoing conditions are not satisfied, the overall average and the standard deviation of the previous consecutive 40 results, including the non-complying sets, should be calculated and the appropriate steps taken if the overall average strength twice the standard deviation is less than the specified work cube strength.

4.21 WORKMANSHIP

a. Placing of reinforcement

Reinforcement shall be accurately placed and maintained in the position described on the drawings or elsewhere to the entire satisfaction of the Engineer. Bars intended to be in contact at passing points shall be securely wired together with 16 gauge annealed soft iron tying wire.

Binders and the like shall tightly embrace the bars and any slackness or misplacement of bars shall be rectified before the Engineer is called for inspection. Spacers of approved design shall be used for ensuring the correct positioning of the bars and diagonal wiring shall be provided to ensure rigidity of all assembled units of reinforcement. The vertical distance required between successive layers of bars in beams or similar members shall be maintained by the provision of mild steel spacer bars inserted at such intervals that the main bars do not perceptibly sag between spacers. The rates for reinforcement must include for all requisite wiring, spacers and precast concrete blocks to maintain the required spacing and cover. All bars are to be bent in accordance with BS 4466: 1969.

Cover of concrete to the reinforcement shall be, unless shown otherwise:-

Columns - 40mm minimum to main bars

Base - 50mm minimum to main bars

Beams - 25mm minimum to main bars

Slab - 15mm minimum to main bars

Wall - 25mm minimum to main bars

Raft slab - 100mm minimum to main bars

Splices to future work shall be covered in a manner approved by the Engineer to prevent rusting and deterioration. Before any concreting is carried out the approval of the Engineer as to the correctness of the fixed reinforcement shall be obtained but such approval shall not remove the responsibility for the correctness of the placing from the contractor. During concreting a competent steel fixer shall be in attendance on the concrete gang to make minor adjustments to the position of bars should they become displaced.

b. Mixing of Concrete

All concrete shall be mixed in batch mixing machines. Hand mixing shall not be permitted. All mixing machines shall be of the fixed drum types and not smaller in size than 0.40/0.28 CM drum mixers will not be permitted. The mixer shall be of the type equipped with an accurate measuring device designed so that no unauthorised person can tamper with the valve or vary the quantity of water delivered once this has been approved and set. The mixing procedure to be adopted by the Contractor shall be approved by the Architect.

The Architect shall approve mixing of each batch. Mixing of each batch shall continue until the concrete is uniform in colour and, in any case, for not less than two minutes after all the materials and the water is used in the drum. The entire contents of the drum shall be discharged before the materials for the succeeding batch are fed into the drum. Upon completion of the day's mixing, the drum shall be thoroughly cleaned free of adhering concrete.

c. Distribution of Concrete

The concrete shall be distributed from the mixer to the position required by approved means, which do not cause separations or otherwise impair the quality of the concrete. All equipment shall be cleaned before commencing mixing and distribution and be kept

free from set concrete. All concrete must be in position and consolidated before the initial set is commenced and the contractor shall ascertain the initial setting time for the brand of cement being used and ensure that his means of distribution are such that it is impossible for concrete to have set prior to placing.

Distribution by means of mortar pane generally will be permitted, but for important large structures such as slabs, large beds and elsewhere instructed by the Engineer the minimum requirements shall be wheelbarrows, ramps and runways over the reinforcement.

d. Placing of Concrete

Before placing of concrete commences, the formwork shall be examined and any accumulated water and rubbish lying therein shall be removed. The concrete shall be placed as near to its permanent position as is practicable and shall not be worked along the formwork to that position. It shall not be dropped from a height not handled in a manner likely to cause separation of the aggregate or loss of the cement matrix. In columns and other similar members the bottom shall be first filled to a depth of between 150mm and 200mm with a cement mortar consisting of sand, cement and water with the sand and cement in the same proportion as that specified for the general mix in that member. The mortar shall have a consistency such that it will work up the formwork and fill in spaces, which may occur due to close spacing of reinforcement in the splice. This mortar must be placed immediately in advance of the concrete and shall not be allowed to attain its initial set before placing the main concrete for the member. Each layer of concrete, while being placed, shall be consolidated by the approved methods of ramming/ tamping or mechanical vibration so as to form a dense homogeneous material free from honeycombing water and air holes or other blemishes. Concrete shall be placed continuously until completion of the part of the work between the specified construction joints. Approved working joints shall be made whenever stopping of concrete placing occurs. In general, concrete shall be placed in a single operation to the full thickness and depth of slabs, beams and similar members and, in any case, shall be placed in horizontal layers not exceeding 750mm deep in walls, columns and other similar members:-

e. Vibration

Mechanical vibrators or hand tamping must be used in placing all reinforced concrete work unless the Enabel Supervising Engineer and the Consultant have approved specially designed mixes and preliminary work cube test results have been obtained without their use. Rates for all reinforced concrete work include for this. Where mechanical vibration is required the contractor shall allow for using two vibrators at any one time.

f. Working joints

Working joints shall be of an approved shape and placed at right angles to the axis of the member. The contractor shall submit his proposals for the design and position of all joints on a drawing to the Architect for his approval well before construction is commenced. The position of day-to-day working joints may be determined so as to meet the requirements of the contractor's concreting programme.

Wherever new concrete is to be placed against concrete that has hardened, the face of the old concrete shall be cut back not less than 20mm and all-loose particles removed. The face shall then be wire brushed and thoroughly cleaned with water and then coated with a neat cement grout immediately before placing the concrete shall be well rammed and compacted against the prepared face before the neat cement grout sets.

g. Protection of Concrete

Newly placed concrete shall be protected by approved means from rains, sun and dry winds, and exposed faces shall be kept moist with polythene sheets or hessian coverings or other approved means for at least 7 days. Under no circumstances shall concrete be

worked upon until it has reached a cube strength of 140kg per square centimetre. Immature concrete shall be protected from damage by falling debris excessive loading vibrations, running or standing water, abrasives or other influences likely to impair the quality or strength of the finished work.

h. Concrete in Excavation.

The length and widths of the excavation shall be as necessary for the proper construction of work below ground and in accordance with the Preambles contained in the section 'Excavation and Earthwork'. Blinding concrete has been measured for the net width required for concrete structure and foundations below ground level. Blinding has not been measured to the extra width, if any required for working space. The Architect shall decide the depths where these are not given on the drawings. Any obstructions or unusual solids encountered during the excavation shall be reported to the Architect and dealt with as then instructed.

i. Removal of formwork.

The period elapsing between placing the concrete and removing the formwork shall be sufficient to allow the concrete to mature to the extent of being able to maintain its own weight and any constructional and structural loads imposed without damage. The Architect's approval for the removal of the formwork shall be as tabulated below:

Position of Formwork	Minimum striking Time
Vertical sides of wall, columns, beams, etc	2 days
Soffits of beams & slabs (props left)	7 days
Slab and props	14days
Bottom boards of piles (intermediate support left in)	12 days
Soffits of beams under 6m span	16 days
Additional: Period for each 0.6m span in excess of 6m span with a maximum of 28 days	1 day

The formwork shall be removed in all cases by gradual easing without jarring and the process shall be such that the sharp edges of the concrete are not chipped and spilled away. If the imposition of a load is anticipated, props shall be provided in an approved manner after removal of the formwork and before the imposition of the loads.

j. Surface finishes

Upon removal of the formwork any honeycombing or damaged surfaces or other imperfections shall be reported to the Architect. No surfaces shall be repaired or otherwise treated until an inspection has been carried out by the Architect and his instructions or approval to remedial work (if any) have been given or obtained.

Concrete surfaces, which are to be plastered or rendered, are to be hacked or roughened by an approved means to form a key.

Sawn formwork is measured for all surfaces requiring support and subsequently concealed or plastered.

k. Precast Concrete

Where precast concrete members are specified, these shall be constructed in moulds of

approved design and samples from the moulds shall be approved before quality production of the member is commenced to requirement of BS 8110. Large precast members shall be lifted only at points, which will not damage the member, and if necessary temporary bracing of timber shall be used to case the member until it is in position. Small lintels and other small members may be cast in-situ at no extra cost at the contractor's option. Allowance must in all cases be made for any extra reinforcement to counteract temporary stresses whilst handling, transporting and hoisting precast concrete members. Moulds for precast units described as finished fair on exposed surfaces shall be lined with plywood or hardboard to leave a fair finish on the exposed concrete face when the mould is removed.

The concrete shall be of the grade specified on the drawings but with maximum aggregate size 12mm and shall be thoroughly vibrated in the moulds and shall not be removed until seven days after placing the concrete.

Care must be taken that no concrete is allowed to become prematurely dry and the fresh concrete must be carefully protected from the rain, sun and wind by means of 'Sisal-kraft' paper, well-wetted sacking, wet sand or other approved means. This protective layer and the concrete itself must be kept continuously wet for at least seven days after the concrete has been placed.

Prices for precast concrete shall include for all moulds, reinforcement as specified, hoisting and fixing in the position required. bedding and pointing as described and temporary props and other necessary supports.

4.22 WALLING

a. Water

Water shall be as previously specified in 'concrete work.'

b. Cement

Cement shall be as previously specified in 'concrete work'.

c. Fine Aggregate

Fine aggregate shall be as previously specified in 'concrete work.'

d. Coarse Aggregate

Coarse aggregate shall be as previously specified in 'concrete work' and shall comprise aggregate of 6, 10 and 20mm gradings in equal proportions

e. Lime

Hydrate limes for cement/lime mortars shall comply with B.S.890 semi-hydraulic class 'B' calcium limes

f. Joints

The joints of brickwork may be finished by one of the following methods.

- ◆ With a flush joint as the work proceeds this joint being formed of the actual mortar used in bedding the bricks.
- ◆ Struck or recessed joint formed in the mortar as the work proceeds when it has gone some way towards setting. Recessed pointing must be even and not vary in depth where not recommended otherwise the recess shall be 6mm deep.
- ◆ Joints raked out while mortar is soft and cleaned down and pointed at completion. When the joints are raked out and pointed later the pointing mortar should be of a composition similar to that of the bedding mortar.
- ◆ Joints raked out and left as key for plaster or roughcast.

g. Concrete Blocks

Solid and hollow concrete blocks for walls comply with BS. 6073 type 'A' except that the recommended mix shall be 1:3:6 cement; fine and coarse aggregate respectively by volume and are to have sharp arises. Blocks are to be manufactured on site in approved block making machines and shall be solid or two cavity hollow types as specified on the drawings. No damaged blocks shall be used in walling and half or other part blocks required to maintain bond shall be cut true and even.

The concrete is to be placed into the moulds in thin layers and shall be properly tamped or vibrated to secure complete consolidation without voids or flaws produce smooth surfaces and sharp straight corners.

Blocks shall be cast on loose pellets and after removal from the moulds shall be carefully stored under for at least 24 hours before the pellets are removed. The blocks shall thereafter be stored under cover for a further seven days protected from the sun and drying of the blocks may commence on the ninth day after manufacture and no blocks may be used within 14 days of their production.

The minimum compressive strength of the concrete blocks shall be not less than: -
Average of 7.0 N per square millimetre.

Concrete louvre blocks shall be of an approved type and manufacture. They shall be with inclined faces and have overall size 450 x 150 x 150mm (excluding lip protruding outside the bedding face).

h. Stone

Stone for walling shall be hard, dense, and stone from an approved quarry with accurately dressed faces on all sides.

Stone walling described as load bearing shall have a minimum crushing strength of 14 Newtons per square millimetre and shall comply with BS 5628L: Part 2.

i. Fair face work

Walls described as finished with a fair face shall be constructed with blocks selected for their uniformity of size and with a smooth exposed face with no chips, blemished, pinholes or cracks. Walling shall be pointed with a neat flush joint as work proceeds and on completion shall be brushed down and left thoroughly clean.

j. Wall reinforcement

All wall described as reinforced shall be reinforced with hoop iron 25mm wide or similar reinforcement centrally in every alternative joint (vertically for the full length of the walls, lapped and crimped 300mm at running joints and full width of wall at angles and intersections).

k. Mortar

The mortar used for walling shall be composed of one part of cement to four parts of sand (1:4) measured in gauge boxes and thoroughly mixed dry and preferably with an approved mixing platform with water added afterwards until all parts are completely incorporated and brought to a proper consistency and used within the hour. No partially or wholly set mortar will be allowed to be re-used or re-mixed.

l. Workmanship

All blocks and stone to be wetted before laying out the top of walling where left off, shall be well wetted before recommencing building, walls to be kept wet three days after building. All walling to be built true, plumb and level with all perpends vertical and in line and work shall not rise more than 900mm above the adjoining work and all such risings are to be properly raked back.

m. Setting out

The Contractor shall provide proper setting out rods and set out on the same all work showing openings, heights, cills and lintels and shall build the various walls and piers to the thicknesses, widths and heights shown upon the Drawings. No part of the walling shall be carried up more than one metre higher at one time than any other part and in such cases the joining shall be made in long steps so as to prevent cracks arising and all walls shall be levelled round at floor and wall heads.

n. Bonding walling

All blocks shall be properly bonded together and in such a manner that no vertical joints in any one course shall be within 100mm of a similar joint in the courses immediately above and below. Alternative courses of walling at all angles and intersections shall be carried through the full thickness of the adjoining walls. All perpend, reveals, quoins and other angles and joints of the walls, etc, shall be built strictly true and square.

o. Damp proof course

Damp proof course between foundations walls and the over-site concrete slab shall be hessian based bitumen strip to BS 743 type 5A the same width as the block walls. The damp proof course shall be bedded in cement mortar (1:4) with 150mm-end laps and full width at passings and angles. Damp proof courses are required on all external and internal foundation walls.

4.23 Roofing

Aluminium sheet roofing

- **Materials**

Aluminium roofing shall be colour coated industrial aluminium roof sheeting (Hula span A7) manufactured by Hulet of Republic of South Africa (RSA) or other approved manufacturer, and shall conform to the requirements of BS 3428 type 'A'. The gauge and the surface finish of the sheets shall be as recommended by the manufacturer, in writing, and approved by the Architect. All accessories shall be of aluminium alloy.

- **Fixing**

The sheets shall be fixed to steel angle or timber purlins with aluminium alloy bolts and nuts. The bolts shall be at least 50mm longer in the shank than the purlin to which they are fixed. All bolts shall have approved washers.

Fixing of the sheet must conform strictly to the printed instructions or otherwise to the requirements of CP 143 part 1 BS 2855.

4.24 CARPENTRY

Timber Generally

The timber for carpentry and joinery shall be specified and obtained from an approved saw mills.

The timber for carpentry shall be Second or Select Grade for strength.

The timber shall be reasonably straight grained.

All timber for the Works is to be purchased immediately the Contract is signed and is to be open-stacked for as long as possible before use or kiln drying.

All timber as it arrives on the site shall be inspected by the Project manager, and any timber brought on to the site and not approved must be removed forthwith.

All timber and assembled woodwork shall be protected from the weather and stored in such a way as to prevent attack by termites, insects or fungi.

Both to be second strength Grade P5 or equivalent. Whilst either timber is suitable, intermixing of species will not be accepted.

The Contractor is permitted to propose substitute species but these shall not be used without the written approval of the Project manager and no adjustment shall be made to the basic rates for softwood trusses in the event of a substitute species being accepted.

a. Insect Damage

All timber shall be free from live borer beetle or other insect attack when brought upon the Site. The Contractor shall be responsible up to the end of the maintenance period for executing at his own cost all work necessary to eradicate insect attack of timber which becomes evident, including the replacement of timber attacked or suspected of being attacked, notwithstanding that the timber concerned may have already been inspected and passed as fit for use.

b. Seasoning of Timber

All timber shall be seasoned to a moisture content of not more than 18% for carpentry and 15% for joinery. The Contractor's price must include for any kiln drying that may be necessary to achieve these figures.

c. Workmanship

All carpentry shall be executed with workmanship of the best quality. Scantlings and boarding shall be accurately sawn and shall be of uniform width and thickness throughout. All carpenter's work shall be left with sawn surfaces except where particularly specified to be wrought.

All carpentry shall be accurately set out in strict accordance with the drawings.

All structural timbers shall be frame or jointed together as is most appropriate in the circumstances in accordance with the rules of good practice. Joints must be executed in strict conformity with the drawings.

All joints shall be secured with a sufficient number of nails disposed as shown on the drawings and rates must include for the jointing of timbers. Surfaces must be in good contact over the whole area of the joint before securing. Holes for nails must be pre-drilled undersize; holes for bolts must be bored slightly over size from both sides of the timber and washers must be used under the nut which must be tightened sufficiently to permanently secure the joint but not to crush the timber.

Actual dimensions of scantlings for carpentry shall not vary from the specified dimensions by more than 3 mm in deficiency or excess but must be uniform throughout. Boards 25 mm thick or less shall hold up to the specified size. All timbers shall be as long as possible and practicable, in order to eliminate joints.

d. Joints

All nails, screws, bolts, connectors, etc., are to be well placed to avoid dissociation in the future.

e. General

The provisions contained in the "Carpentry" section shall apply also to the Joinery Section where applicable.

f. Species of Timber

The following timber of First or Prime Grade for appearance shall be used for Joinery Work in conjunction with the term "hardwood" or "approved hardwood":-

STANDARD NAME	BOTANICAL NAME
Podo (for grounds, etc. only)	Podocarpus spp
African Mahogany	Khaya nyasica
Mninga	Pterocarpus Angolensis
Iroko (Mvula)	Chlorophora excelsa
Mkongo (East African Afzelia)	Afzelia Quanzesis

The following may also be used as "local hardwood" (referred to hereafter) with the Project manager's approval:-

STANDARD NAME	BOTANICAL NAME
Adina; East African Afrormosia;	East African Afzelia

g. Generally

All joinery work shall be accurately set out on boards to full size for the information and guidance of the artisans before commencing the respective works, with all joints, iron work and other work connected therewith full delineated. Such setting out must be submitted to the Project manager and approved before such respective works are commenced.

All joinery work shall be cut and framed together as soon after the commencement of the building as is practicable, but not to be wedged up or glued until the building is ready for fixing same. Any portions that warp, wind or develop shakes or other defects within six months after completion of the Works shall be removed and new fixed in their place together with all other work which may be affected thereby, all at the Contractor's own expense.

All work shall be properly morticed, tenoned, housed, shouldered, dovetailed, notched, wedged, pinned, bradded, etc., as directed and to the satisfaction of the Project manager and all properly glued up with the best quality approved glue.

Joints in joinery must be as specified or detailed, and so designed and secured so as to resist or compensate for any stresses to which they may be subjected. All nails, springs, etc., are to be punched and puttied. Loose joints are to be made where provision must be made for shrinkage; with glued joints where shrinkage need not be considered and where sealed joints are required. Glue for load-bearing joints or where conditions may be damp must be of the resin type. For non-load-bearing joints or where dry conditions may be guaranteed casein or organic glues may be used. All exposed surface of joinery work shall be wrought and all arises "eased-off" by planning and sand-papering to an approved finish suitable to the specified treatment.

h. Ironmongery

All ironmongery shall be fixed with screws to match. Before the woodwork is painted, handles shall be removed, carefully stored and re-fixed after completion of painting, and locks oiled and left in perfect working order. Prices for fixing locks must include for organizing master keying systems if required and all keys shall be labelled with door references marked on approved labels before handing to the Project manager on completion.

4.25 PAINTING

a. Colour range

All painting shall be carried out in colours selected by the Consultant.

b. Materials

Paints generally shall be ready mixed and supplied by one of the manufacturers listed below and delivered to the site in sealed containers clearly labelled with the a manufacturer's name, type of paint and colour. Oil based priming paint shall comply with B.S.2521-2524 inclusive.

Jotum Paints
Coral Paints
Galaxy Paints
Leyland Paints (T) Ltd
Robbialac Paints (T) Ltd
Sadolins Paints (T) Ltd
Goldstar Paints Tanzania Ltd

Paints are to be used strictly in accordance with the manufacturer's instructions and no contamination by mixing with other brands or materials will be permitted. Thinning is only permitted in so far as it is in accordance with the manufacturer's printed instructions.

c. Preparation

All surfaces to receive treatment are to be clean and dry before paint application and surface irregularities are to be removed by filling or the use of suitable abrasives. d)

d. Plastered surfaces

Internal plastered wall surfaces generally are to be treated with plastic emulsion paint. Surfaces are to be allowed to dry out thoroughly prior to paint application. All crack and surfaces imperfection are to be cut back and filled with a patent filler in accordance with the manufacturer's instructions and rubbed down to a true and even surface.

Apply one primer coat thinned with water and two subsequent coats of Leyland's 'Leymure Co-polymer' or other approved plastic emulsion paint in accordance with the manufacturer's instructions. Where specified internal plastered wall surfaces are to be painted gloss. In addition to the preparation described above, apply one coat of Leyland's P 20 or other approved alkali, resistant primer and flat down with 320 grade 'wet or dry' abrasive paper. Apply two coats Leyland's Leylac Polymeric gloss finish or other equal and approved gloss paint lightly rubbed down coats in accordance with the manufacturer's instructions.

Dimensions of the manholes and are to be as short as possible and are to be surrounded with 150mm concrete up to the first pipe joint.

The manhole shall be constructed in accordance with the drawings for typical and special manholes.

Manholes cast iron steps for manholes shall comply with BS. 1247. All steps be hot dip galvanised after manufacture.

Manhole covers and frames shall be in accordance with the requirements of BS. 497 and as specified on the drawings.

e. Concrete beds etc

Concrete beds shall be grade "15" laid to correct falls, 300mm wider than the external diameter of the pipe. Rates are to include for laying in two parts, the first part being laid on the trench bottom 75mm thick and allowed to set before pipe laying is commenced. Individual pipes shall be firmly supported on precast concrete blocks placed immediately

behind the socket and in such a manner that each pipe is accurately position in both line and level and the underside of the barrel is at least 75mm above the top of the concrete.

After the joints have been made and the pipelines satisfactorily tested, the first layer of the concrete bed shall be thoroughly washed down and cleaned and the remainder of the bedding concrete (and the launching or surrounding concrete where required) shall be placed and consolidated under and around the pipe in such manner as not to cause any damage or disturbance to the pipe or joints.

The contractor is to ensure that his, method of placing this second layer of concrete is such that the full length of each pipe is fully supported. The overall depth of beds is to be in accordance with the table given on the drawings. Where pipes are specified to be haunched, the bed shall be brought up with the second layer of concrete to a minimum overall depth of 150mm to the underside of the barrel of the pipes plus half the diameter of the pipe and then sloped up to the top of the barrel of the drain pipes. Where pipes are specified to be surrounded, the bed shall be brought up with the second layer of concrete to a minimum overall depth of 150mm to the underside of the barrel of the pipe and then completely surrounded with concrete with 150mm minimum cover all round. Rates for this item are to include for any formwork required.

f. Trenches and manhole excavation and back filling

The bottom of drain trenches is to be trimmed and consolidated to correct levels and gradients. If any trenches are over- excavated the contractor to fill up to the proper depth at his own expense with concrete grade "10" where required. Rates for drain trenches are to include for grading bottoms, any necessary planking and strutting and keeping the excavations free from water, returning, filling in and ramming ground over and disposing of surplus material to spoil heaps on site. They shall also include for sieving and hand filling trenches where required for the first 300mm over the drainpipes.

Back filling shall be executed with selected material in 150mm layers (300mm layers if a mechanical rammer is used) each layer being well rammed and watered to obtain the maximum compaction. Care should be taken to ensure that no stone or other work is placed within 300mm of such work.

Rates for manhole excavation shall include for levelling the bottoms. All surface material including topsoil, which differs in any nature whatsoever from the substrata, shall in every case be carefully set aside and stored separately from other excavated materials. No claim for extras will be allowed for setting aside topsoil for later use.

g. Pipe laying and jointing generally

All laying and jointing of pipes shall conform generally with C.P. 301. Each cast iron, or concrete pipe shall be tested for soundness before laying by striking with a hammer and any pipe or joint which does not ring true or which shows in any other way any sign of being defective shall be regretted.

Each pipe shall be laid accurately to line and gradient so that the finished pipeline shall be in a straight line both in horizontal and vertical planes. The contractor shall fix properly painted and securely positioned sight rail, the levels and positioning of which shall be checked by the Architect's representatives before the rails are used and as often thereafter as may be necessary. There shall be at no time less than three sight rails in position on each length of pipeline under construction to any one gradient and the sight rails shall be situated vertically above the line of pipes or immediately adjacent thereto.

h. Jointing PVC Drainpipes

The type of joint used for drain PVC pipe is cemented spigot and socket. The jointing procedure is as follows:

- The spigot end shall be chamfered
- Clean spigot and socket with wet cloth and let dry
- Un-grease spigot and socket with acetone
- Mark length of joint and spigot
- Apply first a relatively thick layer of cement onto spigot and then a thin layer into socket
- Flush home the joint to the mark quickly and give at once a 90 twist. vii) Remove pressed out cement
- Do not disturb the joint for five minutes whilst cement is hardening

The cement used shall be supplied by the factory, which is supplying the pipe.

i. Position of floor gullies etc.

The Contractor shall before positioning floor gullies duck-foot bends for ventilating stacks, etc should consult the Consultant and Enabel Supervising Engineer in order to ensure the correct position of these. Failure to do so, shall in no way relieve the contractor from positioning floor gullies, duck-foot bends for ventilating stacks etc in positions, the Consultant and Enabel Supervising Engineer later may direct.

j. Testing

After the drains are laid and jointed and before the trenches are filled in, they are to be tested in the presence of the Architect's representatives. The drains shall be tested in lengths between manholes or such shorter lengths as the Enabel Supervising Engineer or the Consultant may approve.

Water shall be passed into the length under test until such time as all the air has been expelled and the line is full of water and subjected to a head of 1500mm at the upstream end. The test shall be considered to be satisfactory if there is no visible leakage, see page or weeping from any of the pipes of joints and if the head of water in a 76mm diameter upstand tube fitted at the upstream does not fall at a rate faster than 12mm per minute per 30 metres length. The contractor shall make such time allowance as may be necessary for the pipe to absorb water being subjected to test.

Manholes are to be tested for water- tightness in the same way as for drains by filling with water but not exceeding 1500mm head.

The contractor is to supply all testing apparatus and materials necessary for these tests and provide all labour and assistance required. Any failure whatsoever in the drainage system to withstand the specified tests and any defects appearing are to be made good and the drains re-tested to the satisfaction of the Architect.